



JAPANESE PATENT OFFICE

(11) Publication Number: JP 02303442 A

(43) Date of publication: 19901217

(51) int. Cl : A01M017-00

(ICS) A01M013-00  
A23B007-152

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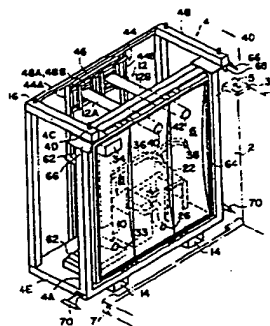
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19890516 JP 01-122034

## FUMIGATION OF CONTAINER AND APPARATUS THEREFOR

(57) Abstract:

**PURPOSE:** To carry out fumigation treatment with a single container by closing an opening of a container with a gas-tight door in the opening of the container and charging a fumigation gas into the container.

**CONSTITUTION:** An opening 2 of a container 1 is closed with a gas-tight door 6 attached to a frame 4 of a fumigation apparatus and a fumigation gas is charged to the container. The content of a container unloaded from a ship can be fumigated by directly connecting a fumigation apparatus to the container and, accordingly, the time required from the unload to the shipping can be remarkably shortened.



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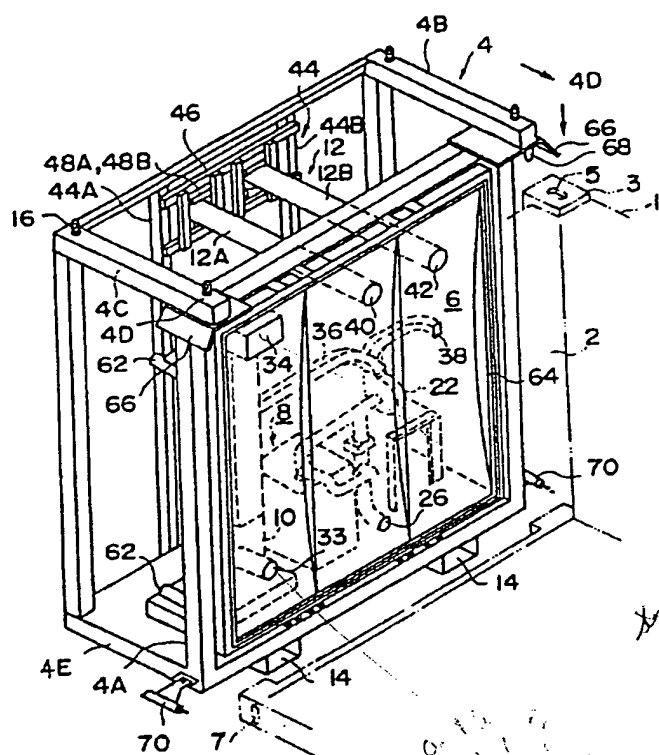
Patent Number: JP2303442  
 Publication date: 1990-12-17  
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 Applicant(s):: HITACHI PLANT ENG & CONSTR CO LTD  
 Requested Patent: ☐ JP2303442  
 Application Number: JP19890122034 19890516  
 Priority Number(s):  
 IPC Classification: A01M17/00 ; A01M13/00 ; A23B7/152  
 EC Classification:  
 Equivalents: JP2094203C, JP8013230B

### Abstract

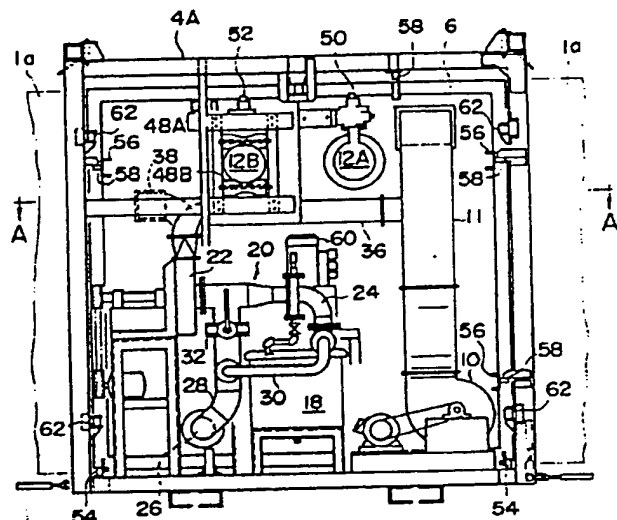
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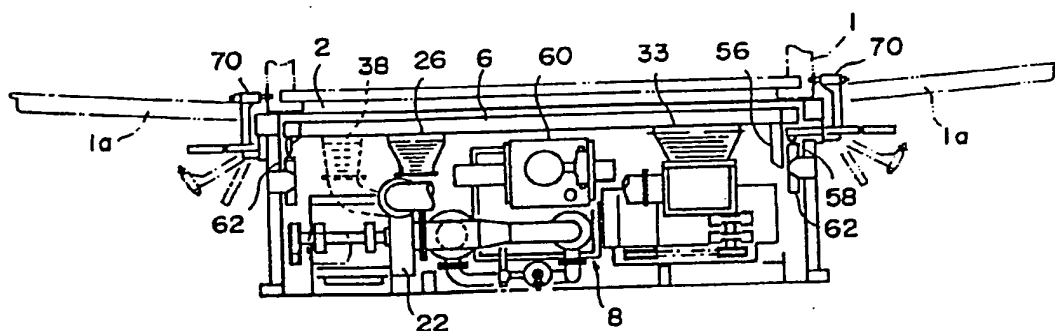
第 1 図



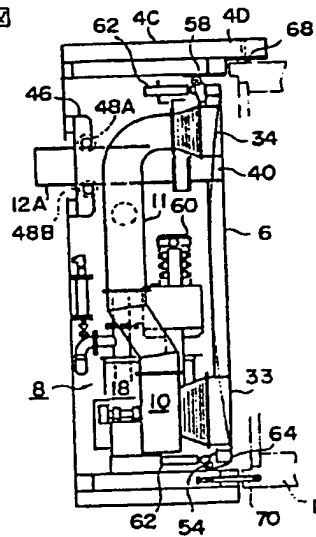
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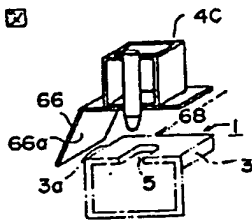
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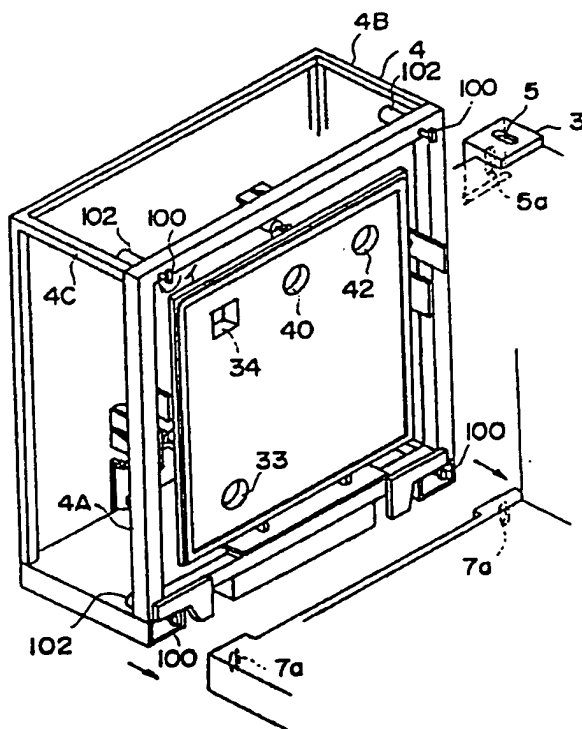
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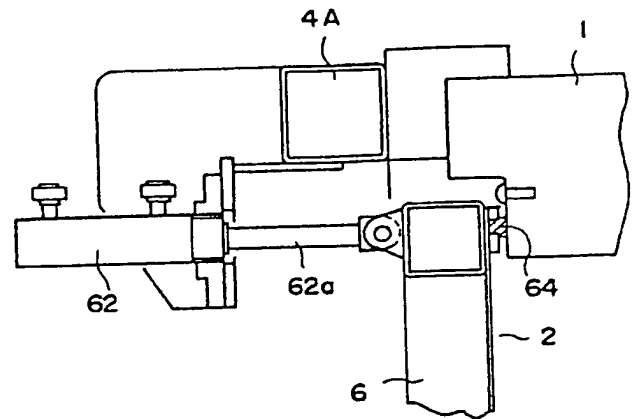
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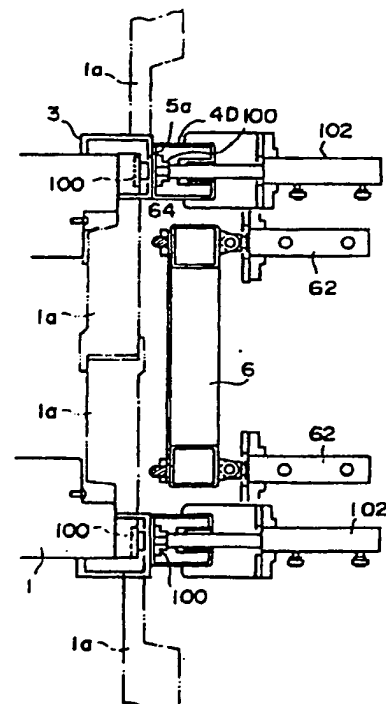
第 7 図



第 6 図



第 8 図



[19] JAPAN PATENT AGENCY (JP)  
[12] PATENT GAZETTE (A) No. 2-303442

[11] Publication of Patent Application

[51] Int Cl. <sup>5</sup>	Identification mark	Internal Agency Number		
A 01 M 17/00	Q	8405-2B		
13/00		8405-2B		
A 23 B 7/152		6946-4B		
		6946-4B	A 23 B	7/152

[43] Publication date: December 17 1990

Examination: Not requested Number of Claims: 7 (Total 9 pages)

[54] Title of Invention: **FUMIGATION OF CONTAINER AND APPARATUS THEREFOR**

[21] Patent Application Number 1-122034

[22] Date of Application: May 16 1989

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## SPECIFICATIONS

### 1. Title of the Invention

Fumigation of container and apparatus therefor

### 2. Claims

- (1) A method of fumigating a container in which, when the container is open and the container opening has been sealed with an air-tight door, fumigation gas is introduced into said container and fumigation is performed.
- (2) An apparatus for fumigating containers, such apparatus characterized by providing fumigation unit that consists at least of a gas injection device that injects fumigation gas into a container and an airtight door that seals the opening of the container, and a detoxication unit that processes the fumigation gas in the container, such fumigation unit also providing a unit mounting device that is fixed to the container and the air-tight door of the unit matching the opening of the container.

- (3) The apparatus for fumigating containers described in Claim 2, the unit mounting device being provided with an engagement member that engages the sling fittings of the container.
- (4) The apparatus for fumigating containers described in Claim 3, the engagement member being so formed that lock pins engage the orifices in the upper sling fittings of the container, and being provided with guides that guide the lock pins into said orifices of the container.
- (5) The apparatus for fumigating containers described in Claim 4, the guides being formed as plate-shaped fittings possessing inclined surfaces that guide the lock pins into the orifices in the container fittings while in contact with the edges of the sides of the upper sling fittings.
- (6) The apparatus for fumigating containers described in Claim 2, being a fumigation unit that is provided with an airtight door that is freely movable on a frame, and that is provided with a clamping device that clamps the airtight door that closes the opening of the container into the opening of the container.
- (7) The apparatus for fumigating containers described in Claim 2, being a fumigation unit that is provided with a system of tubing consisting of exhaust tubes that send the exhaust gases from inside the container to the detoxication unit, and connecting tubes that communicate with said exhaust tubes and are connected to the exhaust tubes from other fumigation units.

### **3. Detailed Description of the Invention**

#### **Field of application in industry**

This invention relates to the treatment of fumigation gas for goods such as for example fresh vegetables that are stored inside containers, and more particularly to a method of fumigation and apparatus therefor that prevents leakage of the fumigation gas that is supplied into the containers.

#### **Prior art**

Imported foodstuffs such as fresh vegetables and the like that are transported by such means of transport as shipping and aircraft must be subjected to specified treatment in order to eliminate insects and the like that are specified by law. For example, in fumigation treatment

by means of hydrocyanic gas, a concentration of  $1.8 \text{ g/m}^3$  to be maintained for 15 minutes is specified, and in order to prevent damage from the chemicals, this treatment time must not exceed 30 minutes.

In fumigation treatment of the prior art, fresh vegetables were either removed from the container to a fumigation shed, or alternatively, the entire container was removed to the fumigation shed. Moreover, when containers contained bulk grains, specially constructed containers provided with fumigation gas tubing were also employed in order to perform fumigation.

For example, when a container filled with fresh vegetables was unloaded from a ship, the container would be transported by trailer to a fumigation shed near the port, and the fresh vegetables would be shifted from the container into the shed and treatment would be performed with the fumigation gas at the specified concentration for the specified period of time, whereupon the fresh vegetables would be packed back into the container, and would be transported to the market.

In the method of placing the entire container itself in the fumigation shed, gas supply pipes that supplied the fumigation gas into the interior of the container were provided inside the shed and fans to agitate the gas within the container were connected to the gas supply pipes. The fumigation gas was dispersed by the agitator fans that were disposed inside the shed and was uniformly dispersed after several minutes. In this state, the fans to agitate the gas within the container were started up and forcibly transported the fumigation gas through the gas supply pipes into the interior of the container. The fumigation gas that was transported into the interior of the container flowed towards the rear door of the container, and the flow of gas was carried into the corners of the container. The fans to agitate the gas within the container circulated the fumigation gas inside the shed through the container producing a uniform concentration of the fumigation gas inside the container, and the treatment was continued in this state for the specified period of time.

In both the preceding methods, when the fumigation treatment was complete, fresh air was introduced into the shed from the exterior to replace the exhaust gas. The exhaust gas was sent to a detoxication unit and treated.

**Problems addressed by the present invention**

Because under the method of the prior art, the treatment is performed inside a sealed shed, the airtightness of the shed itself becomes an issue. When the fumigation gas is supplied, a volumetric increase occurs within the system proportional to the amount of gas supplied. In other words, the pressure rises inside the shed as the fumigation gas is supplied, which causes leakage of gas to the exterior. Consequently, if the shed is not fully airtight due to human operator error, or if the sealing members become degraded or if there is any defect in the sealing devices, airtightness is reduced, and the gas leaks into the outside air.

Turning to a consideration of the method of treating goods such as fresh vegetables that are to be fumigated, the loading of the goods into the fumigation shed and the treatment of the goods involves the transfer of the goods between the container and the fumigation shed, which is time-consuming, and must be done with great care in order to avoid damaging the goods that are to be fumigated, such that the operation is inconvenient. More particularly, in the case of fresh vegetables, the length of time required for the operation can have a serious impact on the degree of freshness of the vegetables, which will affect the value of the vegetables.

Moreover, when the container itself is transferred into the shed, part of the fumigation gas that is injected into the shed is supplied into the container, and thus the efficiency of use of the fumigation gas is poor.

More particularly, in the case of containers, the airtightness of the container is not complete due to the presence of the areas of contact between the container body and the container door casing, and the refrigeration unit in the case of reefer containers, and of drainage and pressure equalisation orifices and the like, while the leakage of fumigation gas in older containers is a particular problem.

It is an objective of the present invention to perform fumigation treatment in the container body, and to provide a fumigation apparatus that prevents the leakage of the fumigation gas that is supplied to the container.

It is a further objective of the present invention to provide a fumigation apparatus in which the fumigation unit can be simply and securely mounted on and demounted from the container.



It is a further objective of the present invention to provide a fumigation apparatus that permits the treatment of the exhaust gases from a plurality of containers in a single detoxication unit.

### **Means employed in order to overcome such problems**

In order to achieve the aforementioned objectives, the present invention provides a method of fumigation wherein, when the container is open, the container opening is sealed with an airtight door and fumigation gas is injected into the container.

Moreover, the airtight door is attached freely movably to the frame of the fumigation unit, and the fumigation apparatus is formed by clamping the airtight door by means of a clamping device to the opening in the container.

Moreover, unit mounting device that provides a fumigation unit consisting of at least an injection device for injecting the fumigation gas into the container and an airtight door for sealing the opening in the container, and a detoxication unit for processing the fumigation gas inside the container, with the airtight door of said fumigation unit matching the opening of the container and a unit mounting device being fixed to the container. Engagement parts that engage the sling fittings in the container are provided in such unit mounting device.

Moreover, the fumigation unit provides a system of tubing that consists of an exhaust tube that sends the exhaust gas from the interior of the container to the detoxication unit, and a communicating tube that connects the exhaust tubes from other fumigation units.

### **Action**

After the opening of the container has been sealed by means of the airtight door, the fumigation gas is injected into the interior of the container, and hence it is possible to perform the fumigation treatment with high reliability and without fumigation gas leaking into the exterior.

The fumigation apparatus can be connected directly to the container when it has been unloaded and fumigation can be performed, and hence the period of time required from unloading until dispatch is greatly reduced.

Moreover, because the unit mounting device that fixes the fumigation unit is attached to the container opening, the work of mounting the fumigation unit is simplified and it is very easily possible to handle a plurality of containers.

Moreover, the engagement parts that employ the container sling fittings to fix the fumigation unit in place employ lock pins and lock fittings, and hence the unit mounting device is simple in structure, and the mounting and demounting of the fumigation unit can be performed by inserting the lock pins in the orifices of the sling fittings and by engaging the lock fittings in the orifices of the sling fittings.

### **Practical embodiments**

The following is a description of a practical embodiment of the present invention by reference to the drawings.

Figure 1 shows an oblique view of a fumigation unit of the fumigation apparatus envisaged by the present invention. In the drawing, the fumigation unit provides a frame 4 that possesses a frame part that meets the circumference of container opening 2 at door 1a of container 1, and airtight door 6 that closes off container opening 2 through which the load is placed in and removed from the container is attached freely movably on front 4A of such frame. Moreover, an injector 8 that generates the fumigation gas and injects the fumigation gas into the interior of the container, a circulation fan 10 that circulates the fumigation gas that has been injected into the interior of the container and ensures that the fumigation gas is uniformly distributed, and an exhaust gas tubing system 12 that introduces outer air into the container when the fumigation gas is exhausted and that transports the fumigation gas that had filled the container to the detoxication unit that will be described subsequently, are provided on the inside of frame 4. The two upper frames 4B and 4C that form the upper part on airtight door 6 side possess frame projection parts 4D that extend forwards from the front of the frame, and the guides, positioning devices and engagement devices for fixing frame 4 to the rear of the container are provided in such frame projection parts 4D.

Fork insertion parts 14 to enable the lifting of the fumigation unit by fork lift are provided in base frame 4E, such fork insertion parts being formed of square section hollow steel tube, and being capable also of being employed as a base when the fumigation unit is placed on the ground. Moreover, four hook engagement parts 16 to enable lifting by hooks when the fumigation unit is lifted by crane are provided in upper frames 4B and 4C.

Next, the constitution of the equipment within the frames is described on the basis of Figures 2 and 3.

Injector **8** consists of a gasifier that gasifies the fumigation gas such as hydrocyanic acid HCN or methyl bromide  $\text{CH}_3\text{Br}$  and the like, a tubing system **20** that mixes the gas from the gasifier with the air in the container and transports it as fumigation gas, and an injection fan **22** that injects the fumigation gas into the container.

The outlet of gasifier **18** is connected by means of gas supply tube **24** to the intake side of injection fan **22**, and the gas supply tube is connected at a certain point on its length by air intake tube **28** to air intake **26** that is provided in airtight door **6** and the intake side of the injection fan, and small amounts of air from the air supply tube are distributed by bypass tube **30** to the gasifier. The air sent from bypass tube **30** is intended to dilute the fumigation gas in gasifier **18** in order that highly concentrated fumigation gas does not remain in the gasifier.

A manually operated valve **32** is disposed in air intake tube **28** on the downstream side of the connection to the bypass tube, and the ratio of the amount of air that passes through bypass tube **30** and valve **32** can be adjusted by adjusting the extent of opening of the manually operated valve.

Circulation fan **10** draws fumigation gas from intake **33** that is disposed in the lower part of the airtight door and ejects the fumigation gas through outlet **34** that is disposed in the upper part of the airtight door, and thus causes the fumigation gas to circulate through the container and maintains uniform concentrations of the gas.

The output side of injection fan **22** communicates through injection tube **36** with circulation current duct **11** on the output side of circulation fan **10** and injects into the circulating air flow, or alternatively, is connected to injection port **38** that is provided in the airtight door and supplies gas into the container through the injection port as indicated by the broken lines in Figures 2 and 3, with either of such constitutions being selected as appropriate.

In exhaust gas tubing system **12**, one end of supply tube **12A** is fixed to supply port **40** and one end of exhaust tube **12B** is connected to exhaust port **42**, while the other ends of both tubes are supported freely movably by tube support member **44** and are so constituted as to be able to follow the movement of the airtight door. Tube support member **44** fixes roller

support frame **46** in support columns **44A** and **44B** that are provided in frame **4**, and rollers **48A** and **48B** are disposed freely rotatably in the roller support frame in order to clasp the tubes from above and below. Supply valve **50** and exhaust valve **52** that are opened when gas is to be exhausted are provided in supply tube **12A** and exhaust tube **12B** respectively.

Airtight door **6** is so formed as to be slightly smaller than the inner dimensions of front frame **4A** and is so disposed as to be freely movable within the frame. Moving wheels **54** are disposed in the bottom of the airtight door, and guide rollers **58** that guide and move are provided in the frames on both sides and on the top of the airtight door.

Moreover, a hydraulic unit **60** is also disposed in frame **4** and a plurality of cylinders **62** that are driven by the hydraulic pressure from the hydraulic unit is also provided, and pistons **62a** of such cylinders are connected to the reverse side of the airtight door. After the fumigation unit has been mounted in container opening **2**, the cylinders are activated and the action of the pistons of the cylinders presses the airtight door in the direction of the container opening and clamp the airtight door into contact with the circumference of the container opening, as illustrated in Figure 6. At this time, packing **64** of the airtight door comes into contact with the circumference of the container opening and maintains an airtight seal between them.

The unit mounting device fixes the fumigation unit to the container and thus possesses an upper engagement members that consist of guide fittings **66** that are formed on frame extension parts **4D** on the two upper sides that constitute front frame **4A** and lock pins **68** that engage container sling fittings **3**, and a lower engagement part that possesses lock fittings **70** that engage the container at one end while the other end is supported freely rotatably in the frame.

In the upper engagement part as shown in Figure 4, the lock pins project into the lower surfaces of the two frame extension parts, and the distance between these lock pins is so set as to be equivalent to the distance between the crane hook engagement orifices **5** through which pass two hooks at the upper corners of the container.

Lock pins **68** are disposed forward of the aforementioned front frame **4A**, and are so disposed as to match hook engagement orifices **5** when the frame is in contact with the circumference of the container opening. Guide fittings **66** that possess fan-shaped guide

surfaces **66a** that are in contact with side edges **3a** of the container sling fittings are fixed in the frames around the lock pins.

Guide fittings **66** are formed of single sheets of metal bent into obtuse angles and fixed to the frames with the bent sides facing downwards. The guide surfaces of the two guide fittings then both face towards the insides of the frames and the distance between the positions of the bends formed in the guide surfaces is set at about equal to the distance between the outer edges of the two sling fittings. Consequently, if, as indicated by the arrows in Figure 1, lock pins **68** are positioned over sling fittings **3** and the fumigation unit is lowered when the front frame is in contact with the circumference of the container opening, slippage of the fumigation unit in the direction of the sides of the containers is corrected by the combined actions of guide surfaces **66a** of the guide fittings and of side edges **3a** of the sling fittings, and lock pins **68** can be securely engaged in orifices **5** of the sling fittings.

The lower stop part acts after the lock pins have been engaged in the orifices of the sling fittings, and fixes the fumigation apparatus. Thus, lock fittings **70** are rotated from the position indicated by the double dot line to the position of the unbroken line in Figure 3, and are engaged in orifices **70** of the sling fittings that are provided in the lower side surfaces of the container.

Next, a further practical embodiment of the unit mounting device is described by reference to Figures 7 and 8.

Hooks **100** are provided in the container lifting orifices **5a** in front frame **4A** that faces towards the container opening. Hooks **100** are disposed at the ends of the pistons of the hydraulic cylinders **102** and are rotated by hydraulic cylinders **102**. Lifting orifices are formed in and pass through container sling fittings **3** and such orifices engage hooks **100** on the sides facing airtight door **6**.

In this practical embodiment of the invention, the fumigation unit may be lifted by fork lift or alternatively may be raised by crane and may be positioned at the container opening. The fumigation unit is shifted towards the container opening and four hooks **100** are simultaneously inserted into lifting orifices **5a** and **7a** of the sling fittings, whereupon hydraulic cylinders **102** are activated and the hooks are rotated and engage the lifting orifices.

Next, the detoxication unit is described.

Figure 9 is an oblique view of a detoxication unit mounted on a motor vehicle. In the drawing, exhaust tube **12B** of the fumigation unit is connected by means of exhaust duct **76** to the intake side of exhaust fan **74**. The output side of the exhaust fan communicates through a first duct **78** with a combustion furnace **80** and through a second duct **82** with a dilution part **84**. In combustion furnace **80**, the hydrocyanic acid gas exhaust gas is burnt and is then vented to the atmosphere through first exhaust port **86**. In dilution part **84**, the methyl bromide exhaust gas is mixed with air from dilution fan **88** and diluted, and is then vented to the atmosphere through second exhaust port **90**. **92** and **94** are respectively a first and second manually operated valve employed for the treatment of the exhaust gases, **96** is control panel, **98** is the fuel tank and **110** is the burner.

Figure 10 shows the constitution of the tubing of the exhaust system when a plurality of fumigation units **A** and **B** is connected to the detoxication unit. In each of the fumigation units, communicating tubes **102** and **104** are connected to the exhaust tubes on the upstream side of the exhaust valves, and communicating valves **106A**, **106B**, **108A** and **108B** are disposed in the vicinity of the ends of the communicating tubes. If for example, the exhaust gas from fumigation unit **B** is sent to the detoxication unit through fumigation unit **A**, the exhaust tube from fumigation unit **A** is connected to the detoxication unit, and the exhaust valve in the exhaust tube of fumigation unit **B** is closed. Moreover, the communicating tubes of fumigation units **A** and **B** are linked through the connection tube **110** and communicating valves **106B** and **108A** in the connecting tube are opened, whereupon the fumigation unit is started and the fumigation gas from the fumigation unit **B** travels from the exhaust tube of fumigation unit **B** through the communicating tube and the connecting tube and is sent to fumigation unit **A**, and then passes through the communicating tube of this unit and flows into the exhaust tube, and is sent together with the exhaust gas from fumigation unit **A** to the detoxication unit.

Next, the action of the fumigation apparatus is described.

The container is transported to the fumigation treatment yard, and the container door is opened. The fumigation unit that has been transported by fork lift is then fitted to the container opening, whereupon the hydraulic units are activated and the hydraulic cylinders operate and seal the container opening. In other words, the airtight door is guided by the door guide parts of the frame and closes the container opening so that the packing of the airtight

door is firmly in contact with the entire circumference of the container opening. While in this state, the clamping pressure of the hydraulic cylinders is applied from the reverse side of the airtight door and thus clamping the airtight door in the direction of the container opening, and providing even greater assurance of the airtightness of the container.

After the fumigation unit has been mounted on the container, the exhaust tubes of the fumigation unit are connected to the exhaust duct of the detoxication unit and the preparations for the fumigation treatment are complete. Next, the air supply valve and exhaust valve are closed, and the circulation fan and injection fan are started, and the gasifier is started. The air within the container is drawn through the circulating air suction port and is ejected from the ventilation port by means of the circulation fan and is circulated through the interior of the container. The air drawn in through the injection air suction port passes through the bypass tube and is sent to the gasifier and is mixed with the gasified injection gas to generate the fumigation gas. Such fumigation gas is injected by means of the injection fan into the injection port or the circulation duct. Because the circulation fan is causing the air in the interior of the container to circulate, the fumigation gas is picked up and dispersed by such air currents, with the concentration of the gas being uniform after such dispersal. Fumigation treatment is performed for the specified period of time under these conditions.

When the fumigation treatment is complete, the circulation fan is allowed to continue operating and the air supply valve and the exhaust valve are opened. The exhaust fan of the detoxication unit is started up and this causes the exhaust gas within the container to be exhausted through the exhaust tubes and the exhaust duct. Thereupon, in the case of hydrocyanic acid gas, the first exhaust valve is opened and the second exhaust valve is closed and the hydrocyanic acid gas is passed through the first duct to the combustion furnace where the gas is treated. In the case of methyl bromide, the first exhaust valve is closed and the second exhaust valve is opened, the dilution fan is started, outside air is introduced into the fumigation gas that has been transported by the exhaust fan, the fumigation gas is diluted and is then vented into the atmosphere.

#### **Effects of the invention**

In the present invention as described in the foregoing, when the container opening has been closed by the airtight door of the fumigation apparatus, the fumigation gas is injected and hence there is no leakage of the fumigation gas into the external atmosphere, and fumigation treatment may be formed with a high degree of reliability.

Because fumigation is performed with the fumigation unit in direct communication with the container after it has been unloaded, the period of time required from unloading until dispatch is greatly reduced.

Because the unit mounting device is employed in order to fix the fumigation unit in the container opening, the task of mounting the fumigation unit is simplified, and the method may readily be applied to large numbers of containers.

Moreover, because the present invention is so constituted as to employ the sling fittings of the container in order to fix the fumigation unit, no special means is required in the container for the mounting of the fumigation unit, and hence the unit mounting device is simple, while because the unit mounting device consists of lock pins and lock fittings, the fumigation unit can be easily mounted and demounted, such that the operability of the fumigation unit is high and work efficiency is improved.

#### 4. Simplified description of the drawings

Figure 1 is an oblique view of the fumigation unit that constitutes the fumigation apparatus that is envisaged by the present invention, Figure 2 is a front view of fumigation unit illustrated in Figure 1, Figure 3 is a cross-sectional view along the line A-A in Figure 2, Figure 4 is a side view along the line B-B in Figure 2, Figure 5 is an expanded oblique view of portion A in Figure 1, Figure 6 is an explanatory drawing of the state in which the container opening is closed by means of the airtight door, Figure 7 is an oblique view of a further practical embodiment of the mounting device for the fumigation unit, Figure 8 is an explanatory drawing illustrating the action of the unit mounting device that is illustrated in Figure 7, Figure 9 is an oblique view of the detoxication unit, and Figure 10 is a schematic drawing of the exhaust tubing system when the exhaust gas from a plurality of fumigation units is treated by a single detoxication unit.

1 ... Container, 2 ... Container opening, 3 ... Sling fitting, 4 ... Frame, 6 ... Airtight door, 8 ... Injector, 10 ... Circulation fan, 12 ... Exhaust tubing system, 22 ... Injection fan, 60 ... Hydraulic unit, 62 ... Cylinder, 66 ... Guide fitting, 68 ... Lock pin, 70 ... Lock fitting

Agent: Yoshinao Nakano, Patent Attorney